



A4BLUE PROJECT- Adaptive Automation in Assembly For BLUE collar workers satisfaction in Evolvable context

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A4BLUE, funded in the frame of Horizon 2020 TOPIC FOF-04-2016, aims to develop and evaluate a new generation of sustainable, adaptive workplaces that can deal with evolving requirements of manufacturing processes and human variability. A4BLUE will introduce adaptive automation mechanisms for efficient and flexible execution of tasks, ensuring constant and safe human-machine interaction as well as advanced and personalised worker assistance systems, including virtual / augmented reality and knowledge management capabilities to support them in the assembly and training related activities. Furthermore, A4BLUE will provide methods and tools to determine the optimal degree of automation in the

new assembly processes by combining and balancing social and economic criteria to maximize long term worker satisfaction and overall process performance.

The 3-year project is being carried out by a first-class international consortium led by IK4-TEKNIKER (Spain) and involving prestigious universities such as RWTH Aachen University (Germany) and Cranfield University (UK) and companies such as Airbus Operation SAS (France), Compañía Española de Sistemas Arenonauticos - CESA (Spain), Engineering-Ingegneria Informatica SPA (Italy), Illogic Società a Responsabilità Limitata (Italy) and Ingeniería de Automatización y Robótica KOMAT SL (Spain) and CiaoTech srl (Italy).

A4BLUE's project progress

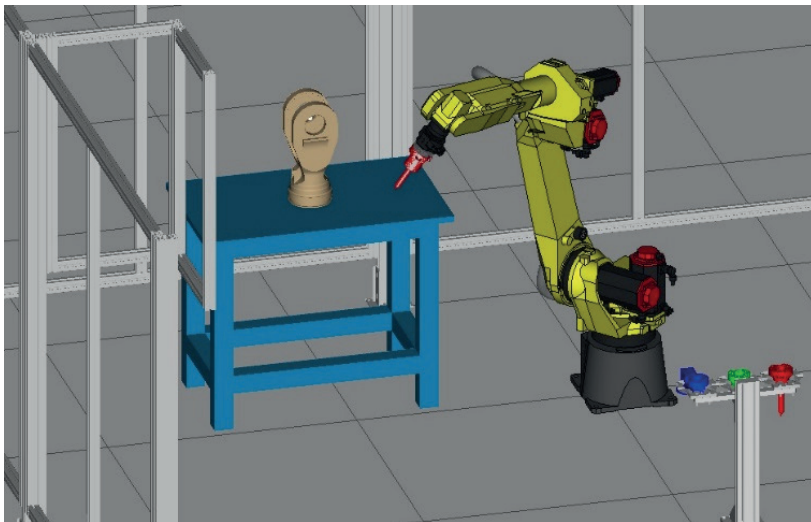
During the last six months, impressive progresses have been achieved by the A4BLUE consortium in terms of technical developments and strategy for further exploitation of the project results. In this newsletter, the following points are illustrated:

- 1) The activities related to development of the four use case scenarios.
- 2) The development and launch of 'Assembly Work Systems in Future Manufacturing Workplaces: an online user requirements survey'.
- 3) The implementation of prototypes for validation of the A4BLUE concept.
- 4) The initial definition of the exploitation strategy drafted from a first innovation and exploitation workshop.
- 5) A4BLUE and other 4 FOF-funded projects: collaboration to disseminate results.

Use case scenarios

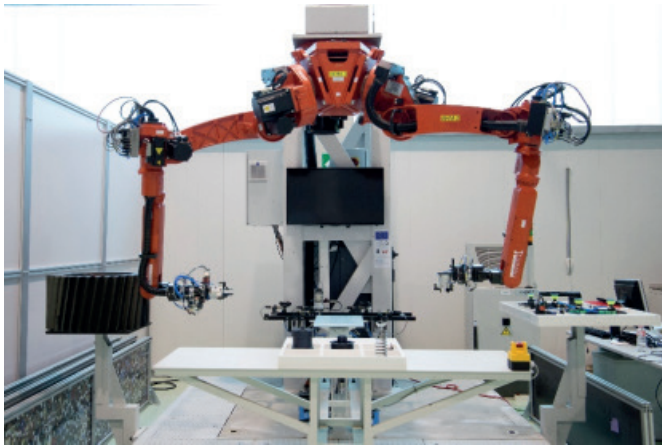
The four use case scenarios where the A4BLUE solution is being instantiated and validated consist of two real industrial scenarios, at Airbus in France and CESA in Spain, and two laboratory-based scenarios, at IK4-TEKNIKER in Spain and RWTH Aachen University in Germany. The scenarios were detailed in the first phase of the project and they have been now improved and completed in a second iteration of design.

For the **Airbus scenario**, A4BLUE will provide a fully traceable quality process improvement for a specific set of assembly personnel including operators, quality supervisors, manufacturing engineers, and process planners. This will be done by introducing a new intelligent system for bolt tightening in hydraulic assembly, involving a Smart Torque Wrench (jointly developed between Airbus and SamOutillage) connected with an Augmented Reality Device (Hololens). The AR device will present information based on each operator's individual profile and skillset to ensure an appropriate level of automation optimizes their execution of the task using the torque wrench. By measuring and recording real-time and synchronized information to operators, supervisors, engineers and process planners the A4BLUE system will provide a new and improved generation of assembly.



For the **CESA use case scenario**, A4BLUE will introduce the first collaborative automation in their assembly facilities, which will reduce the high dependency on manual work within CESA and allow workers to use their time in a better and less exhausting way. In addition, an AR device will also be implemented to provide a new friendlier and easier way of presenting information to the workers as a complete source of guidance, solving the current problem of fragmented information. This will allow a more functional way of sharing "best practice" knowledge between operators

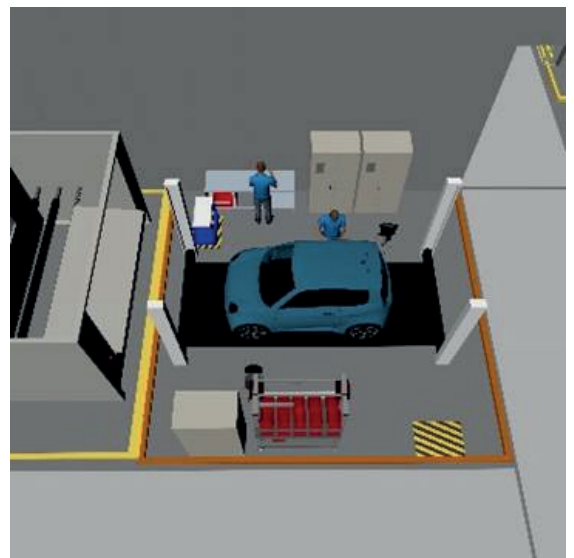
and reduce training needs, as the operators will be guided through the assembly process by information adapted to their individual level of expertise.



The **scenario at IK4-TEKNIKER** is the collaborative assembly of a latch valve in a fenceless environment, including auxiliary activities as initial preparation activities, final inspection and transport of the completed part to the warehouse. The scenario is aligned with the need for incorporating robots that are able to safely and adaptively co-operate with humans in operations that have been until now eminently manual. The scenario involves two robots: a dual arm robot interacting with the worker in close co-operation during the assembly, and a mobile robot performing logistics related operations. Main improvements should come

from adapting the dual arm robot to suit the characteristics of workers to avoid potential ergonomic issues, introducing multimodal interaction (verbal and non verbal) to support different workers' capabilities or preferences, including active safety mechanisms to adapt robot behaviour to different context situations, providing on-the-job guidance adapted to the needs of both the specific worker and operation involved and including decision support capabilities.

Within the **RWTH use case** the A4BLUE solution will be applied to enhance the assembly of electric vehicle prototypes. During complex operations like the assembly of the safety critical brake pedal and the rear light, the worker will be assisted with augmented reality for on-the-job-guidance. This will be designed to improve the quality of work, reduce the training time needed for new employees, and achieve a high level of usability as this is essential for worker acceptance of the AR-solution. Moreover, as the worker spends a lot of time on auxiliary work that does not directly contribute to the value of the product, this will be reduced using an automated tool trolley with efficient controls for short and long-range steering to assist them during the assembly process. The automated tool provision will not only ease physical demands of the worker but also increase their productivity.



Assembly Work Systems in Future Manufacturing Workplaces: an online user requirements survey

The online user requirements survey was a bespoke questionnaire, developed specifically to provide an empirical insight of what technologies and features are considered essential, desirable or unnecessary in the design of future assembly systems. The survey was first developed to identify the initial requirements of A4BLUE consortium partners but was then refined to ensure item simplification, neutrality and suitability for more global participation. The revised survey has now been distributed more widely through social media and to external contacts across sectors and industries. Results so far show a tendency for strong positive reactions towards the concept of developing reconfigurable systems to meet the evolving requirements of both production processes and operators. Participants also tended to consider the use of novel technologies in future assembly systems as desirable, rather than essential. The survey remains open and further analysis will be undertaken at further stages of the A4BLUE

project to update results after wider participation:

<https://ec.europa.eu/eusurvey/runner/A4BLUEAssemblyWorkSystemsInFutureManufacturing-RequirementsSurvey>

Prototypes for validation of the A4BLUE concept

The scenarios definition and the user requirements analysis were the basis for the design of the A4BLUE architecture and its implementation. Prototype developments for the alpha phase have been carried out for validation of the A4BLUE concept, to adapt the architecture and, if necessary, rethink new approaches. Developments have been focused in the adaptive framework, the assistance tools to guide the workers on-the-job and the automation mechanisms themselves. Methodologies to assess the optimal level of automation considering economic and social aspects have also been created.

The A4BLUE adaptive framework alpha prototype is ready to test adaptation to worker profiles and events within the manufacturing environment. For that, the virtual asset representation including the worker model and integration with legacy systems, specifically with Manufacturing Execution Systems (MES), have been implemented.

The assistance tools for the worker includes Augmented Reality (AR) features to guide the worker on-the job through step-by-step procedures and technical documentation provision. First tests have been performed in Airbus where the Hololens AR glasses guide the operator in the bolt tightening operation by using a smart tool.

A4BLUE also introduces adaptive automation within each use case scenario, from dual arm robots and smart tools for assembly, mobile robots for logistics and tools provision, and automation mechanisms for auxiliary processes. Adaptation of automation comes through their integration with the Adaptive Framework, which is performed based on standards, particularly OPC UA (OPC Unified Architecture). Furthermore, the system includes seamless automation interaction modes, such as natural speaking and gestures.

In that context RWTH and Cranfield developed an automation evaluation tool. Its purpose is to determine the optimal automation level in assembly systems, based on socio-economically sustainable evaluation, focusing on a worker-friendly environment. It examines the impacts of using automation technology to understand assembly system behaviour with varying levels of automation, which is determined in two dimensions, the physical and the cognitive automation. The tool assists in the process of choosing resources for an assembly process or rather an assembly station or line and enables selection of the best resources for a specific process, considering both economical and user satisfaction characteristics.

5th Consortium meeting and 1st Innovation and exploitation workshop

From 28 February to 2 March 2018, the A4BLUE partners met for the 5th project meeting in Eibar (Spain). The event was the occasion for partners to analyse the activities performed so far and take crucial decision for the future.



The last day of the meeting was dedicated to the first innovation and exploitation workshop coordinated by Ciaotech. The first part was conceived to provide training on exploitation and impacts within EU funded projects.

In the second part, partners identified the most promising (key) results and characterized them in detail. Finally, the potential risks of the exploitation were identified and a preliminary Lean Canvas for the A4BLUE framework was drafted.

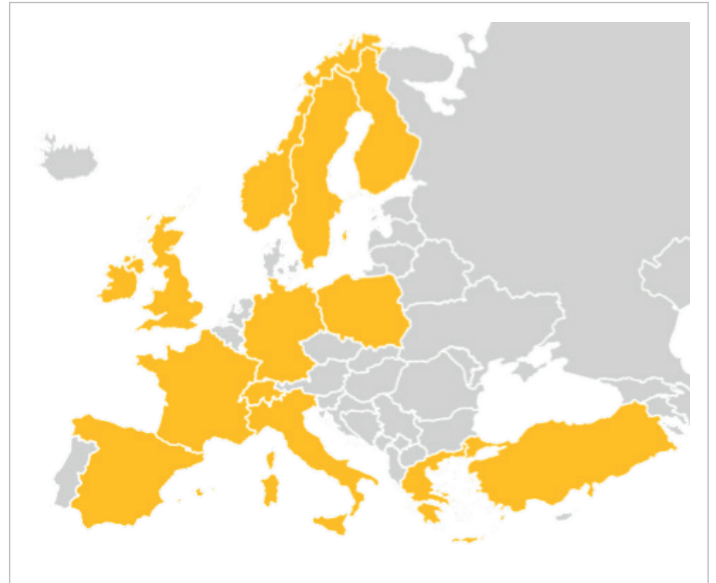
These activities will continue...Stay tuned!

A4BLUE collaboration with FOF-4 projects

The A4BLUE project has joined forces with 4 other projects funded under the European Union's Horizon 2020 research and innovation programme - Factory of the Future (FOF) calls: [Factory2Fit](#), [HUMAN](#), [INCLUSIVE](#), and [MANUWORK](#).

As the five projects entered the second year of their three-year duration in autumn 2017, they teamed up to form a cluster. Based on the common goals they are working towards, the cluster is a forum for sharing project knowledge, progress, and results as they emerge. By combining their efforts, A4BLUE, Factory2Fit, HUMAN, INCLUSIVE, and MANUWORK hope to achieve greater impact and wider adoption of these new developments in advanced manufacturing systems. In the coming months, the cluster will be setting up a website to share news and updates.

This fruitful collaboration has been announced through a joint press release which has been sent out to media and stakeholders on the 21st March and it is available at this [link](#)



Countries covered by the projects' cluster



For more info about the project visit the A4BLUE website at: www.a4blue.eu



IK4-TEKNIKER
(Coordinator)
www.tekniker.es



RWTH Aachen University
(RWTH)
www.pem.rwth-aachen.de



Cranfield University
(CRAN)
www.cranfield.ac.uk



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